HISTORIC ACCOUNTS, RECENT ABUNDANCE, AND CURRENT DISTRIBUTION OF THREATENED CHINOOK SALMON IN THE RUSSIAN RIVER, CALIFORNIA

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ABSTRACT

Despite their threatened status, little was known about the abundance and distribution of Chinook salmon in the Russian River, California, prior to 1999. Recent reviews considered the population extirpated or scarce and the existence of a historic population was questioned. To inform recovery planning efforts, we reviewed historic fishery documents and investigated the current status of Chinook salmon in the Russian River. We counted migrating adults at a seasonal dam using an underwater video system, determined redd distribution along mainstem and tributary habitats, and trapped emigrating juveniles in the lower river from 2000 to 2004. Minimum escapement ranged from 1,383 to 6,081 fish, one-time annual surveys found 558 to 1,044 redds throughout 110 km of the mainstem and more than 250 redds along 22 km of a major tributary, spawning was evident in an additional four tributaries, and we estimated that at least 18,231 to 169,086 juveniles emigrated annually. In contrast to previously published accounts, our 5-year monitoring results documented a relatively abundant, widely distributed, and naturally self-sustaining population. Recent genetic analyses and similarities between our data and historic information dating to 1881 suggest the presence of an ancestral population. However, the extensive planting of juveniles artificially propagated from out-of-basin stock and the paucity of historic field surveys makes the origin and demographic trends of the current population impossible to determine.

INTRODUCTION

Accurate descriptions of historic and current trends in abundance and distribution are fundamental components of threatened species recovery planning. The California Coast Chinook Salmon Evolutionarily Significant Unit (ESU) was listed as threatened in 1999 (U.S. Federal Register 64FR50394, September 16, 1999). The Russian River watershed comprises 18% of the ESU and forms the southern boundary. At the time of listing, however, information regarding the current status of Chinook salmon in the ESU was unavailable and historical accounts of their abundance and distribution were scarce (Myers et al. 1998). The paucity of information on Russian River Chinook salmon, *Oncorhynchus tshawytscha*, has led researchers to conclude that they were a minor component of the historical fishery and may have persisted only as a small population throughout the twentieth century (Winzler and Kelly 1978[1]; Steiner 1996[2]; Moyle 2002).

The origin and historic abundance of Russian River Chinook salmon is enigmatic. There is no information on their presence or absence prior to the first stocking in 1881 (USCFF 1892). Fish were stocked sporadically during the early twentieth century and a more concerted effort to establish a spawning population began in the 1950s and 1960s (Steiner 1996[2]; Myers et al. 1998). These stockings resulted in a minor fishery, but natural reproduction may have been unsuccessful (Jensen 1973[3]). After the construction of Warm Springs Dam and Lake Sonoma in the 1980s, the California Department of Fish and Game (CDFG) began propagating Chinook salmon using local and out-of-basin stock at the Don Clausen Fish Hatchery located on Dry Creek, a major Russian River tributary. More than 2 million juvenile salmon

were released from the hatchery between 1981 and 1998 (Myers et al. 1998). Adult returns, however, ranged between 1 and 304 fish and the Chinook salmon hatchery program was terminated in 1999.

In 1999, the Sonoma County Water Agency conducted a pilot study to assess the effects of a seasonal dam and water diversion facility on Russian River fisheries (Chase et al. 2000[4]). Although designed primarily to evaluate the upstream and downstream passage of threatened coho salmon, *O. kisutch*, and steelhead, *O. mykiss*, Chinook salmon were encountered most frequently. The extension of the pilot study to a 5-year fish passage investigation (Chase et al. 2005[5]; Manning et al. 2005) has revealed the presence of a previously poorly described Russian River Chinook salmon population.

To clarify the historical record and facilitate California Coast Chinook salmon recovery planning efforts, we provide (1) a comprehensive review of historic Russian River fishery documents, (2) the number and timing of returning adults for the years 2000-2004, (3) the distribution of redds in mainstem and tributary habitats from 2002 to 2004, and (4) the number and timing of emigrating juveniles for the years 2000-2004.

STUDY SITE

The Russian River drains a 3,846-km^2 watershed in Mendocino and Sonoma counties. The 177- km mainstem river enters the Pacific Ocean 112 km north of San Francisco, CA (Fig. 1). Stream flow is currently regulated by releases from two permanent reservoirs: Lakes Sonoma and Mendocino. Both reservoirs are located on tributaries and provide summer base flows of 6-9 m^3/s, but winter discharge is largely unregulated. Historic unimpaired summer flows were generally less than 0.57 m^3/s. The Sonoma County Water Agency withdraws water to meet municipal demands at river km (rkm) 37 (above the river mouth) near the town of Forestville (Fig. 1). During the low flow season (April-November) a temporary dam and reservoir is used to enhance groundwater pumping. Mirabel Dam, a 45-m x 4.0-m air and water-filled rubber bladder creates a 5.1-km reservoir termed Wohler Pool. To facilitate upstream fish passage and minimize juvenile entrainment, the dam contains two Denil-style fishways and screened pump intakes with flow bypasses (Manning et al. 2005). Water not diverted through the intakes, bypasses, or ladders spills evenly across the crest of the structure. During periods of non-operation, the dam is deflated and lies flush with the streambed.

The Russian River provides habitat for Federal Endangered Species Act (ESA) threatened Chinook salmon, steelhead, and State and Federal ESA endangered coho salmon. In addition to salmonids, smallmouth bass, *Micropterus dolomieu,* Sacramento sucker *Catostomus occidentalis*, pikeminnow, *Ptychocheilus grandis,* hardhead, *Mylopharodon conocephalus,* and tule perch, *Hysterocarpus traski* are abundant in the river (Chase et al. 2005[5]).

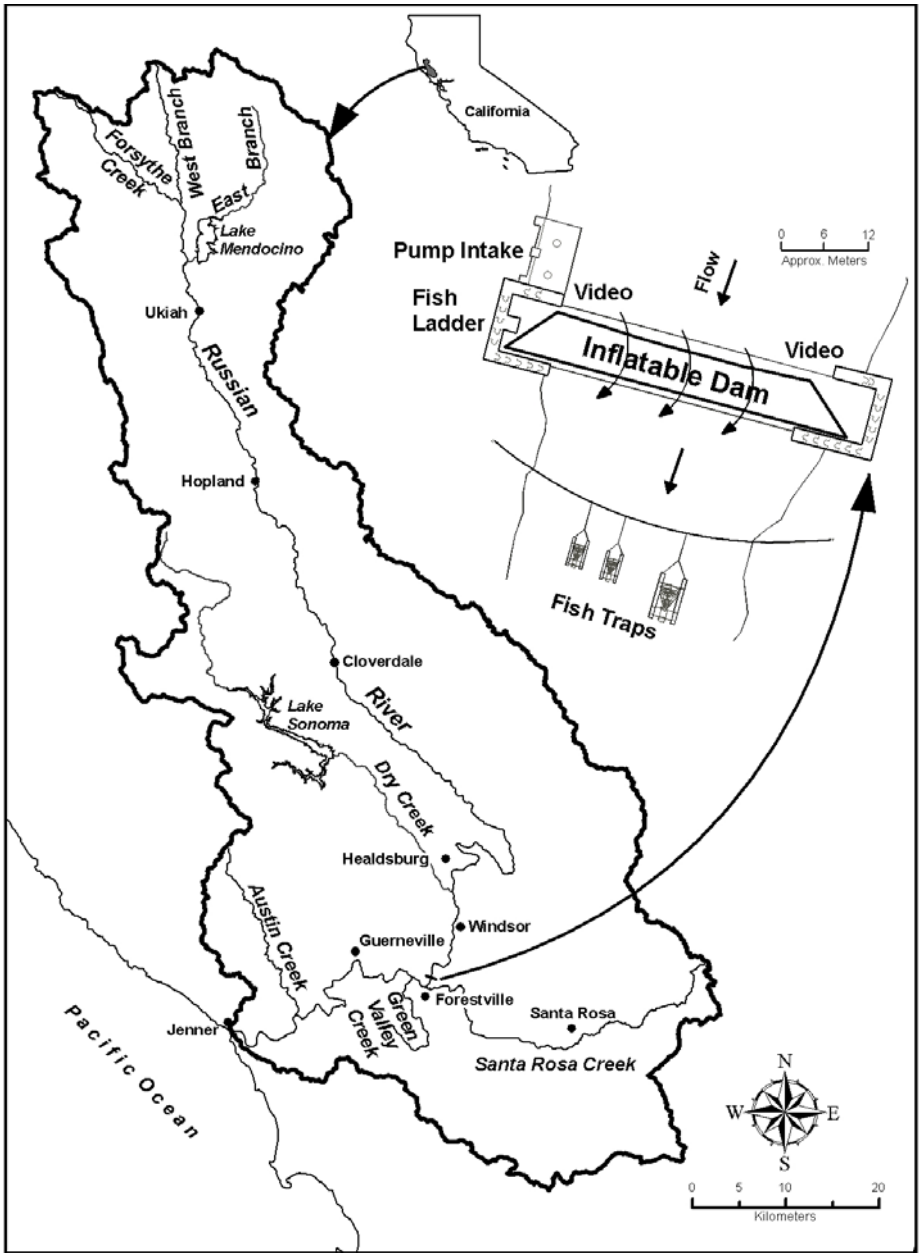

Figure 1. **The Russian River watershed Chinook salmon study area showing major spawning tributaries and detail of the Mirabel inflatable rubber dam sampling site. Underwater video cameras were located at the fish ladder exits on the upstream side of the dam. Rotary screw fish traps captured emigrating juveniles below the dam site.**

METHODS

Document Review

Our search for historic Russian River fishery documents was conducted at the California Academy of Sciences archives in San Francisco, the CDFG regional headquarters in Yountville, the Russian River Historical Society, and the Sonoma County Water Agency archives. Sources included United States Commission of Fish and Fisheries (USCFF) reports, stocking records, CDFG memoranda, field reports, and dated photographs. California Academy of Sciences and Russian River Historical Society searches were conducted during June 2005. Sonoma County Water Agency and CDFG searches were conducted in 2003.

Underwater Video Counts

Adult fish migrating through the Denil-style fish ladders on either side of Mirabel Dam were counted using underwater video systems (Fig. 1). Each system consisted of a high resolution monochrome camera with a wide-angle (105°) lens in a waterproof case, two high intensity red lights in waterproof housings, and a time-lapse videocassette recorder. The camera and lights were housed in custom manufactured steel cases attached to the fish ladder exits. The system was operated 24 h per day between August and January 2000-2004. Because the fish ladders only function when the rubber dam is inflated, videography ended each year when high flow necessitated deflation of the structure.

The time-lapse recorders captured an image every 0.2 s. Preliminary testing demonstrated that even rapidly swimming fish were captured using this interval. Time- and date-stamped videotapes were reviewed on recorders with slow motion and freeze frame capabilities. Trained tape reviewers recorded species and time of passage. Day and night images were clear, but species identification was not possible during periods of high turbidity immediately after storms. Although species could not be differentiated when visibility was low, family level identification was possible under most conditions.

Spawning Distribution

We counted redds along a 110-km reach of the mainstem from the East and West Branches confluence in the City of Ukiah to the town of Windsor once annually from 2002 to 2004 (Fig. 1). In 2003 and 2004, we also surveyed 22 km of Dry Creek from Warm Springs Dam to the stream's confluence with the Russian River. Although we were primarily interested in describing redd distribution, not abundance, we conducted the one-time surveys after peak fish ladder video counts. The mainstem and Dry Creek reaches were divided into sections and drifted by three person crews in kayaks on consecutive days. Redd locations were recorded using hand-held Global Position System (GPS) receivers. During the 2000-2004

study period, Chinook salmon spawning was observed by local, state, and federal fishery biologists in Russian River tributaries outside our survey area. We interviewed these biologists and included their observations in our description of spawning habitat.

Downstream Migrant Trapping

Juvenile Chinook salmon were captured using one 2.4-m diameter and two 1.5-m diameter rotary screw traps located 50 m below the Mirabel Dam site during spring 2000-2004 (Fig. 1). Trap installation date was dependent on stream flow and ranged from 28 February to 20 April. The traps were fished 24 h per day and checked once daily. We removed the traps when catches declined to near zero between 7 June and 3 July each year.

Captured fish were placed in aerated 45 L ice chests, anaesthetized with CO_2, measured, and caudal fin clipped for genetic tissue sample collection and trap efficiency testing. Trap efficiency was determined by mark-recapture and newly clipped fish were released 0.8 km above the trap site. Recaptured and unmarked fish were released downstream. To reduce handling stress, we suspended marking when water temperature exceeded 21˚C and released fish immediately downstream per our National Marine Fisheries Section 10 permit.

Juvenile abundance was estimated using a stratified-Petersen mark-recapture estimator designed for downstream migrant trap data (Bjorkstedt 2005). The Darroch Analysis with Rank Reduction (DARR) approach to estimating downstream migrant population size ameliorates bias associated with small samples and temporal variation in capture probabilities (Darroch 1961; Bjorkstedt 2005). To help partition the mark-recapture data, we alternated clips weekly between the upper and lower lobes of the caudal fin. We marked up to 50 fish > 60 mm fork length (FL) per day. Fish less than 60 mm FL were deemed too small to adequately mark. The proportion of marked to unmarked fish was used to calculate weekly population estimates using the DARR statistical software package (Bjorkstedt 2005). Because we only marked fish longer than 60 mm FL, no mark-recapture estimates were available for early season catches of smaller fish.

RESULTS

Document Review

The United States Commission of Fish and Fisheries (USCFF) produced annual reports of commercial fishing activities, hatchery operations, and research efforts throughout the United States in the late nineteenth and early twentieth centuries. Stocking records reported the planting of 55,000 Chinook salmon fry in the Russian River between 1881 and 1907 (USCFF 1910). The first record of a Russian River commercial fishery appeared in the 1892 report. Although species were not identified, 15,240 kg of salmon were landed using gillnets in the lower river and shipped to San Francisco by rail in 1888 (Table 1). In addition to the reported catch, non-commercial landings of salmon were estimated at 68,040 kg. The 1892

Table 1. Commercial salmon fishery data for the Russian River and Sonoma County from United States Commission of Fish and Fisheries Reports (USCFFF). Report authors are indicated when available. The 1892 and 1895 reports detailed Russian River salmon fishing activities but did not include species identification.

Year	Location	Anglers	Gear type	Chinook salmon (kg)	Salmon (kg)	Source
1888	Russian River	15	gill nets	n.a.	15,240	USCFF 1892
1889	Sonoma Co.	18	gill nets	12,161	n.a.	USCFF 1893
1890	Sonoma Co.	19	gill nets	9,696	n.a.	USCFF 1893
1891	Sonoma Co.	19	gill nets	16,627	n.a.	USCFF 1893
1892	Sonoma Co.	19	gill nets	13,081	n.a.	USCFF 1893
1893	Russian River	"few"	n.a.	n.a.	≤ 4,536	Jordan 1895
1895	Russian River	64	lines[a]	0	n.a.	USCFF 1896
			fyke nets	0		
1899	Sonoma Co.	n.a.	gill nets[b]	0	n.a.	Wilcox 1902
1915	Sonoma Co.	n.a.	gill nets	2,722	n.a.	USCFF 1920
			lines	5,443		
1922	Sonoma Co.	11	haul seine	2,268	n.a.	USCFF 1926
			lines	45,360		

[a] Sturgeon was the only finfish caught in 1895.
[b] No finfish were reported in 1899.

report also detailed the number of salmon captured by month during 1888 (Fig. 2). Catch records from 1889 to 1892 specify Chinook salmon, but only provide summary information for Sonoma County (Table 1). However, the total landings, number of anglers, and gear type were similar to the 1888 record. Jordan (1895) noted the capture of less than 4,536 kg of salmon in the Russian River during 1893, but also failed to identify species. Sonoma County fishery data in 1895 and 1899 reported the use of set lines, fyke nets, and gill nets, but did not record landings of salmon. Chinook salmon appear again in the Sonoma County catch in 1915 and 1922 (Table 1). The listing of Sonoma County fishing activities in USCFF reports ended in 1922.

The stocking and catch of Chinook salmon during the mid-twentieth century was reported primarily by the California Department of Fish and Game. Although we found summary references to Russian River fisheries during the 1940s and 1950s, no comprehensive sampling surveys were conducted. Rich et al. (1944[6]) reported the presence of a small and sporadic coho salmon run, but no known run of Chinook salmon. Shapovalov (1955[7]) also noted the absence of Chinook salmon and Pintler and Johnson (1956[8]) stated that they were sometimes caught during winter in the lower river but were otherwise rare.

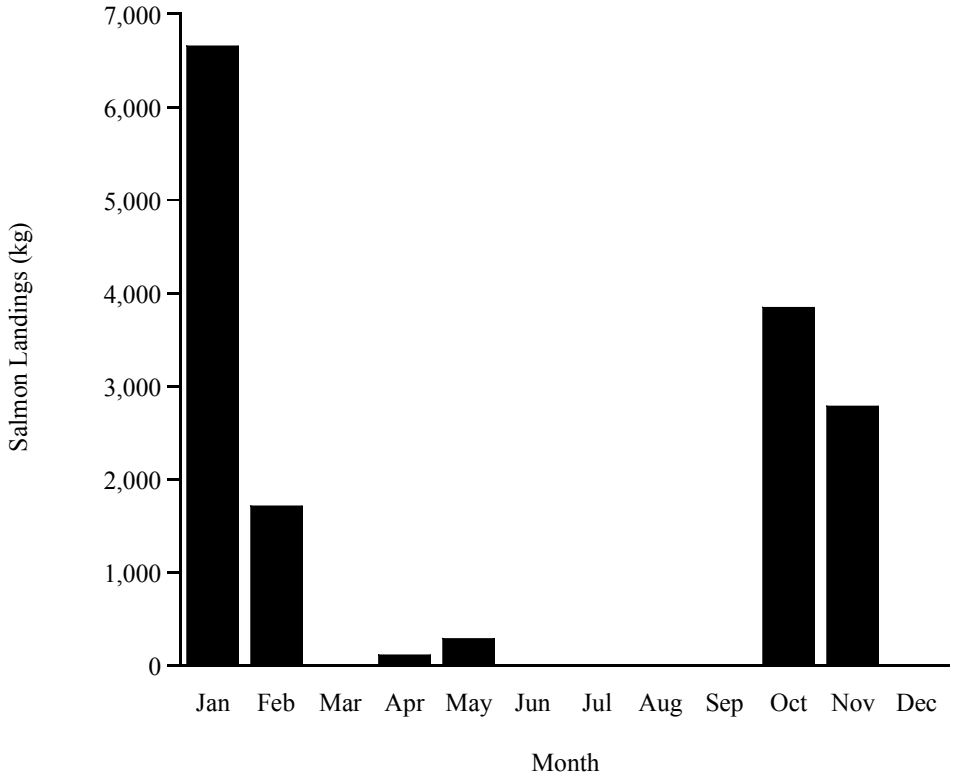

Figure 2. Monthly commercial salmon landings (species not identified) in 1888 from the lower Russian River near the town of Duncans Mills (data from USCFF 1892).

Efforts to establish a spawning population accelerated with the stocking of 2.25 million fry between 1956 and 1960 (Table 2). Surveys conducted from August to mid October 1960 did not find spawning Chinook salmon, but reported the observation of live adult fish and the capture of up to 250 fish by anglers (Day 1961[9]; Hinton 1963[10]). Hinton (1963[10]) noted scattered observations of spawning Chinook salmon, 500-600 fish taken by anglers, and estimated the spawning run at 1,000 fish in 1961. From 1961 to 1970, CDFG planted 1,857,285 juveniles obtained primarily from Coleman National Hatchery in the Sacramento River basin (Table 2). Spawning adults were reported in the upstream portion of the mainstem and large tributaries in 1969 (Vestal and Lassen 1969[11]).

We found only one field survey conducted during the 1970s. From November to March 1970-1973, fyke nets were fished in the lower river to capture adult salmonids for mark-recapture population estimates (B. Cox, California Department of Fish and Game, personal communication). One adult Chinook salmon was captured in December 1970. Summary reports from 1972 to 1991 noted past stocking efforts and estimated annual Chinook salmon returns of 0-500 fish (Anderson 1972[12]; Jensen 1973[3]; Lee and Baker 1975[13]; CDFG 1991[14]).

Table 2. Broodstock sources and numbers of juvenile Chinook salmon released in the Russian River from 1950 to 2000. Hatcheries are noted in parentheses.

Time period	Source river	Juveniles	Reference(s)
1951-1960	Klamath, Sacramento (Coleman)	2,250,000	Hinton 1963[10]; Steiner 1996[2]; Myers et al. 1998
1961-1970	Sacramento (Coleman), unknown[a]	1,857,285	Holman 1968[15]; Nokes 1970[16]; Myers et al. 1998
1971-1980	Klamath (Iron Gate)	73,800	Myers et al. 1998
1981-1990	Russian, Eel, Mad, Ocean[b], Silver[b], Wisconsin[c]; Sacramento (Feather)	1,847,140	Estey 1981[17], 1982[18], 1983[19], 1984[20], 1985[21]; Gunter 1986[22], 1987[23], 1988[24], 1989[25], 1990[26]; Myers et al. 1998
1991-2000	Russian, Eel, Noyo[d], Sacramento (Feather)	349,105	Gunter 1991[27], 1992[28]; Cartwright 1994[29]; Williams 1994[30]; Quinones 1995[31], 1996[32], 1997[33], 1998[34], 1999[35], 2000[36]; Myers et al. 1998
Total		6,377,330	

[a] Myers et al. list 879,885 fish during 1969-1970 from an unknown source.
[b] Ocean King and Silver King were from private hatcheries.
[c] Green River, Washington
[d] Myers et al. 1998 list Sacramento (Nimbus) for 1990-94. Noyo eggs may represent Nimbus strain.

The CDFG began operating the Don Clausen Fish Hatchery located on Dry Creek in 1980 during the construction of Warm Springs Dam and Lake Sonoma. Between 1981 and 1999, the hatchery released more than 2 million fingerlings and yearlings derived from both out-of-basin and local broodstock (Table 2). Annual juvenile releases and adult returns at Don Clausen Fish Hatchery ranged widely (Table 3). Because yearlings were last released from the hatchery in 1998-1999, hatchery returns after 2002 were the progeny of fish produced naturally in the Dry Creek basin (Table 3).

Table 3. **The number of juvenile Chinook salmon released and adults that returned to the U.S. Army Corps of Engineers/CDFG Don Clausen Fish Hatchery located on Dry Creek, a major Russian River tributary. Years extend from July 1 of the first year through June 30 of the second year. Juvenile releases include both fingerlings and yearlings. Adult returns include grilse.**

Year	Juvenile releases	Adult returns
1981-82	102,360	0
1982-83	89,650	1
1983-84	66,120	4
1984-85	211,510	8
1985-86	884,520	65
1986-87	126,557	111
1987-88	79,166	304
1988-89	237,450	233
1989-90	49,807	17
1990-91	110,690	99
1991-92	113,525	125
1992-93	8,877	40
1993-94	50,300	21
1994-95	0	85
1995-96	25,923	33
1996-97	31,990	43
1997-98	7,800	49
1998-99	11,730	4
1999-00	0	2
2000-01	0	29
2001-02	0	10
2002-03	0	306
2003-04	0	262
2004-05	0	211

Underwater Video Counts

Video cameras were installed between August 1and August 22 in 2000-2004 and were operated continuously until flows necessitated deflation of the dam between November and January. The quality of video images was high, but poor water clarity after storms and the variable period of system operation yielded partial counts of total escapement (Fig. 3). Total counts of adult Chinook salmon ranged from 1,383 in 2001 to 6,081 in 2003 (Table 4). Adult fish were first observed in late August and last observed during December, but peak immigration occurred between mid October and mid November each year (Fig. 4). Peak 24-hour counts exceed 1,000 fish on 7 November 2002, 31 October 2003, and 26 October 2004. In addition to Chinook salmon, clear video images of adult steelhead, chum salmon, *O. keta*, pink salmon, *O. gorbuscha*, and Pacific lamprey, *Lampetra tridentata*, were captured during the monitoring period.

Spawning Distribution

We conducted mainstem redd surveys from November 5 to 30 in 2002, 2003, and 2004. Dry Creek surveys were conducted from November 23 to 25 in 2003 and 2004. Adult Chinook salmon were the only fish observed on the spawning grounds. Total redd counts during the one-time surveys followed the same trend as the number of adults recorded on video. In the mainstem, we found 1,044 redds in 2002, 907 redds in 2003, and 558 redds in 2004. Redds were observed throughout the 110-km reach, but most spawning occurred between Cloverdale at rkm 101 and the East and West Branches confluence (rkm 150) near Ukiah (Fig. 5). In Dry Creek, we counted 256 redds in 2003 and 342 redds in 2004. Redd density also increased in an upstream direction along Dry Creek. Mean redd density from 2003 to 2004 was higher in Dry Creek (14 redds/km) than in the upper mainstem Russian River (10 redds/km). Detailed maps of mainstem and Dry Creek spawning sites can be found in Cook (2004[37]).

In addition to the mainstem and Dry Creek, Chinook salmon spawning was also observed or inferred in four mainstem tributaries (Fig. 1). In 2002, dozens of fish were observed spawning in Santa Rosa Creek (S. Brady, City of Santa Rosa, personal communication). In 2003 and 2004, juveniles were captured in downstream migrant traps on Austin Creek (D. Hines, NOAA Fisheries, personal communication) and Green Valley Creek (D. Acomb, California Department of Fish and Game, personal communication). Redds and Chinook salmon carcasses were also observed in Forsythe Creek during 1999 (S. Harris, California Department of Fish and Game, personal communication).

Downstream Migrant Trapping

The installation date of downstream migrant traps was dependent on stream flow and varied from late February to mid April each year. Juvenile Chinook salmon were captured as early as February but most fish were less than our minimum marking size (60 mm FL) until April. During 2000-2005, weekly catches of outmigrant Chinook salmon slowly increased during March and early April, peaked between late April and

Figure 3. A typical underwater video image of Chinook salmon passing through the west side fish ladder exit at Mirabel Dam, Russian River, CA on October 2, 2002.

Table 4. **Weekly underwater video counts of adult Chinook salmon that passed Mirabel Dam on the Russian River, CA during the years 2000-2005. Video recording ceased when the dam was removed each year.**

	Year				
Week of	**2000**	**2001**	**2002**	**2003**	**2004**
1-Aug	0	0	0	0	0
8-Aug	0	0	0	0	0
15-Aug	0	0	1	0	0
22-Aug	1	0	8	0	0
29-Aug	0	3	7	2	1
5-Sep	9	1	18	7	1
12-Sep	38	7	19	20	3
19-Sep	23	12	65	22	8
26-Sep	50	17	1,223	181	16
3-Oct	31	240	113	146	42
10-Oct	115	51	628	512	52
17-Oct	81	10	272	230	651
24-Oct	466	300	153	528	2,287
31-Oct	63	661	505	2,969	185
7-Nov	24	81	2,337	1,282	1,189
14-Nov	182		20	47	221
21-Nov	200		37	92	57
28-Nov	111		14	43	60
5-Dec	19		54		16
12-Dec	14				
19-Dec	17				
26-Dec	1				
2-Jan	0				
Total	1,445	1,383	5,474	6,081	4,789

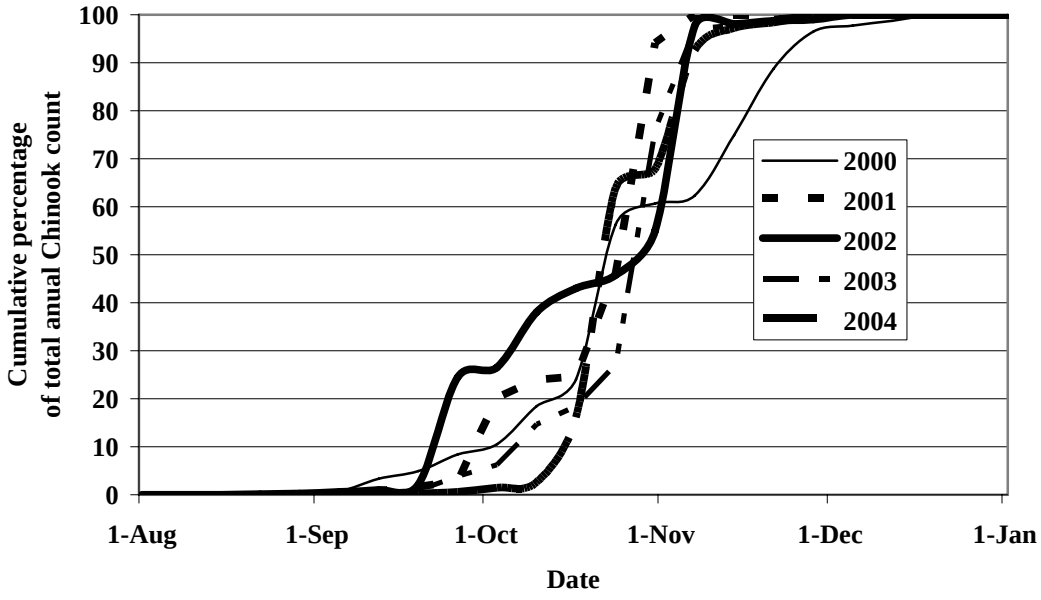

Figure 4. **Run timing of adult Chinook salmon in the Russian River, CA for the years 2000-2004 shown as the cumulative percentage of fish counted at the Mirabel Dam fish ladders.**

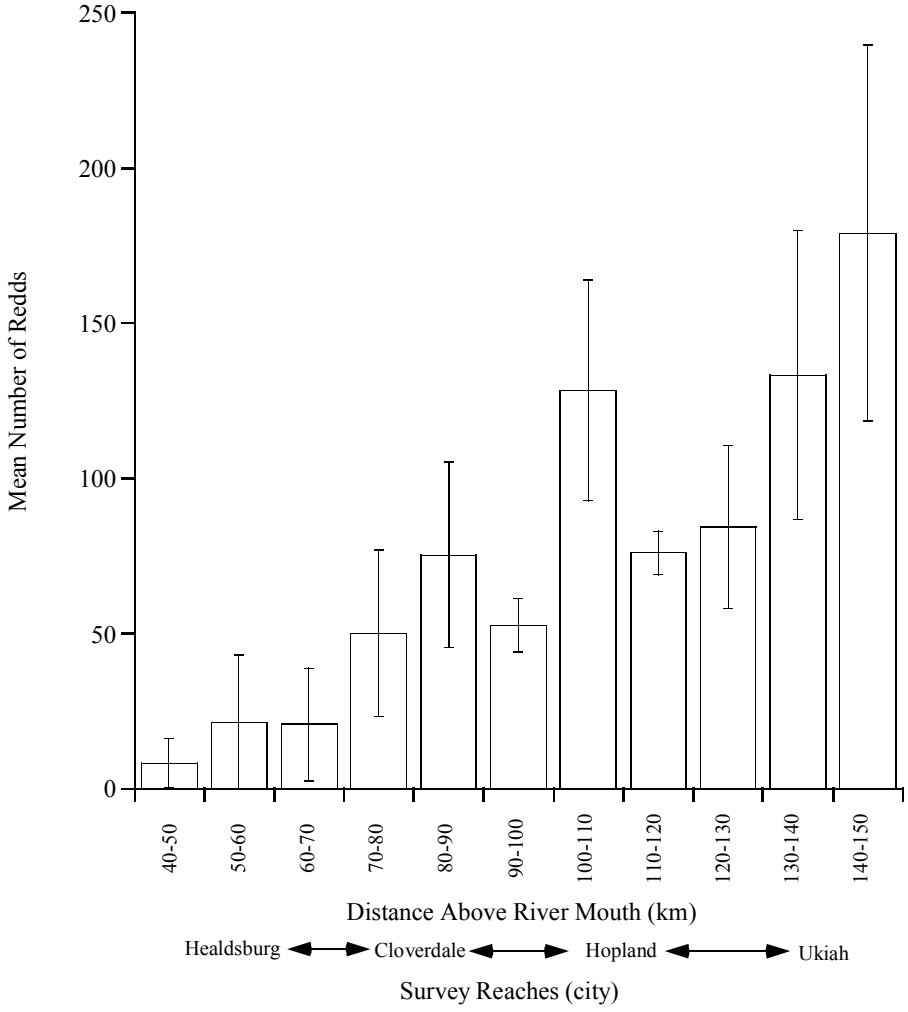

Figure 5. **Mean number of redds observed along 10 km sections of the mainstem Russian River for 2002-2004 (n= 3 years). Error bars depict 1 standard deviation. Cities that delineated approximate survey reach boundaries are also shown.**

mid May, then slowly declined and approached zero by early July (Table 5). Although low numbers of fish were still emigrating when the traps were removed, the sampling period covered the majority of the smolt emigration season. The total number of fish captured ranged from 1,361 in 2000 to 19,319 in 2002 (Table 5). Total trap efficiency was similar each year and ranged from 7 to 11 percent. Mark-recapture population estimates, plus the total number of fish captured before marking was initiated, ranged from 18,231 in 2001 to 169,086 in 2002 (Table 5).

DISCUSSION

Our 5-year monitoring results have documented a relatively abundant, widely distributed, and naturally self-sustaining population of Chinook salmon in the Russian River. The paucity of information in the historical record and lack of recent comprehensive field surveys lead researchers to erroneously conclude that Russian River Chinook salmon were either extirpated or scarce (Steiner 1996[2]; Moyle 2002). Although the existence of a population is no longer in question, its origin and historic persistence remain unknown. Our document review and monitoring results, however, may help resolve questions about the history and status of this threatened population.

There are no records indicating Chinook salmon presence or absence in the Russian River prior to the first stocking in 1881 and the existence of a historic wild population has been questioned (Steiner 1996[2]). The Russian River fishery described in 1888 (USCFF 1892) consisted of an unspecified mixture of salmonids. The 1889 to 1891 catch for Sonoma County did not refer specifically to the Russian River, but listed Chinook salmon landings and total catches, gear type, and number of anglers similar to the 1888 record. The one time stocking of 30,000 fry in 1881 was unlikely to create a Chinook fishery of this size. Steiner (1996[2]) cited the 3.6 to 9 kg individual weight of unspecified salmon in 1888 as too small to represent Chinook salmon. However, we routinely observed fish in that size range during video monitoring and redd surveys. During 8 nights from 6 October to 17 November 2003, we trapped fish at one Mirabel Dam fish ladder exit and found the mean weight of 28 Chinook salmon was 4.9 kg. Data from 1888 documented adult salmonids in the lower Russian River during October and November which coincides with the peak immigration period for Chinook salmon entering the Russian River during our 5-year monitoring program.

While we found correspondence between our immigration data and information in the historical record, the legacy of flow manipulation in the Russian River tempers any suppositions about run timing prior to 1908. Russian River flow has been regulated for nearly 100 years and flow manipulation has been implicated as a factor in population decline and cited as evidence that Chinook salmon may have been absent historically. An interbasin water transfer and hydroelectric facility, known as the Potter Valley Project (PVP), began supplementing Russian River flows with Eel River water in 1908 (Beach 2002[38]). While early flow records are sparse, PVP modifications in 1922 and the completion of Coyote Valley Dam and Lake Mendocino in 1959 caused a 20-fold increase in summer and fall Russian River base flows (Steiner 1996[2]). Historically

Table 5. Juvenile Chinook salmon captured, marked, and recaptured in rotary screw traps below Mirabel Dam on the Russian River, CA. Estimated trap efficiency applies to the period following initiation of mark-recapture. Total population estimate (N) and precision (SE) were calculated using DARR 2.0 software (Bjorkstedt 2005). The traps were not operated during weeks without capture data.

Week of	Year				
	2000	2001	2002	2003	2004
26-Feb			45	332	
5-Mar			74	841	
12-Mar			319	89	
19-Mar			181	169	
26-Mar			[a] 797	346	19
2-Apr	41		908	377	63
9-Apr	158		757	[a] 176	115
16-Apr	154	122	2,279	[b] 17	[a] 672
23-Apr	204	720	2,992	[b] 60	1,911
30-Apr	169	1,338	4,337		1,845
7-May	121	[a] 1,154	1,780	[b] 50	1,631
14-May	174	226	2,056	508	552
21-May	106	76	1,755	690	158
28-May	92	64	704	1,461	150
4-Jun	66	22	192	530	125
11-Jun	47		93	374	31
18-Jun	19		46	186	88
25-Jun	10		4	48	9
July 2				3	
Total Catch	1,361	3,722	19,319	6,257	7,369
Total Marked	n.a.	525	2,804	1,072	1,631
Total Recaptured	n.a.	60	253	90	120
Trap Efficiency	n.a.	11 %	9 %	8 %	7 %
Estimated N (SE)	n.a.	18,231 (5,118)	215,875 (25,922)	37,749 (12,176)	75,586 (16,402)

[a] Date when mark-recapture was initiated

[b] Trap operated for a portion of the week due to high flow

intermittent flow in late summer likely encouraged formation of a seasonal sandbar at the river mouth that may have prevented salmonid immigration before heavy fall and winter rains.

Moyle (2002) concluded that the historic Russian River hydrologic regime was appropriate to support Chinook salmon and the range of river entry dates suggested by our data supports this contention. Although we found that adult fish entered and held in the lower river during August and September, the peak immigration period is often coincident with the first heavy fall rains that would have allowed access to an ancestral population. If current run timing has advanced in response to flow augmentation, however, the phenology of an historic population could have changed within 100 years. Adult migration and spawn timing are genetically controlled traits that can change rapidly in response to anthropogenic and environmental selective factors (Quinn et al. 2001; Quinn 2005). If early returning Russian River adults encountered favorable spawning conditions created by artificially stable fall flows, adult migration timing could have shifted earlier over the 25 to 30 generations since flow augmentation began.

The altered flow regime may have also helped strays from adjacent river systems and non-native stock transfers establish the current population. The possibility that Russian River Chinook salmon are descendants of Eel River fish, mistakenly homing to water transferred from their natal watershed has persisted in the lore of Russian River fisheries. Most of the more than 6 million juveniles stocked from 1950 to 1999 originated from sources outside the Russian River basin including the Klamath, Eel, Noyo, and Sacramento rivers. Recent genetic analyses, however, have demonstrated separation between Eel River, Russian River, and Central Valley Chinook salmon populations (Hedgecock et al. 2002; Bjorkstedt et al. 2005). While the current Russian River Chinook salmon population is not composed of recent Eel River or Central Valley strays, the extensive planting of out-of-basin fish within the California Coast Chinook salmon ESU has likely blurred patterns of historic genetic population structure (Bjorkstedt et al. 2005). Although we cannot discount the possibility that introduced juveniles yielded the current population, it should also be noted that the most recent and extensive artificial propagation effort at Don Clausen Fish Hatchery failed to generate sustainable adult returns.

The low adult returns to Don Clausen Fish Hatchery appear to contrast our adult video counts and spawner distribution surveys. Our video counts are only minimum population estimates but were 20 to 50 times higher than hatchery returns from 2000 to 2004. Because the hatchery last released yearlings in 1998, returns after 2002 were the progeny of fish that spawned naturally in Dry Creek. Our one-time surveys in Dry Creek found more than 250 redds in 2003 and 2004.

The incongruence of hatchery records and our recent observations are indicative of similar trends in the historical data. We found historical documentation of stocking efforts throughout the Russian River basin, but field surveys of spawner abundance and distribution were sparse and inconsistent. Field surveys that described adult Chinook salmon presence appeared to correspond with prior periods of juvenile stocking.

However, the limited timing, duration, and spatial extent of these surveys may have failed to detect a widely distributed population. Agrawal et al. (2005) compiled distribution data prior to the year 2000 throughout the California Coast Chinook salmon ESU and found documentation of spawning Chinook salmon in 54 km of streams in the Russian River basin. Professional biologists queried during the investigation suspected salmon were also present in an additional 148 km of habitat (Agrawal et al. 2005). The observation of fish in only 25% of their potentially occupied habitat makes it unlikely that observers could have reliably estimated population abundance. We suspect similar or less rigor in historical population estimates that were based largely on professional judgment. We found Chinook salmon spawning along 132 km of mainstem Russian River and Dry Creek habitat. It is unlikely that our monitoring program coincided with the sudden appearance of 1,383 to 6,081 adult fish. Since recent genetic studies demonstrated that the Russian River Chinook are not strays from nearby river systems, it is most likely that some level of escapement was occurring in the river for an unknown period of time. The abundance of Chinook salmon throughout the ESU has undoubtedly declined (Myers et al. 1998), but the extent of the decline and trends prior to 2000 are impossible to determine in the Russian River.

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